

RFP 10-47
Attachment D
Technical Proposal

State of Indiana Office of Technology (IOT),
Geographic Information Office (GIO) -
Request for Proposal (RFP)

for

Professional Services to Develop
Local-Resolution National Hydrography Data (NHD)
for the State of Indiana Watersheds

November 13, 2009

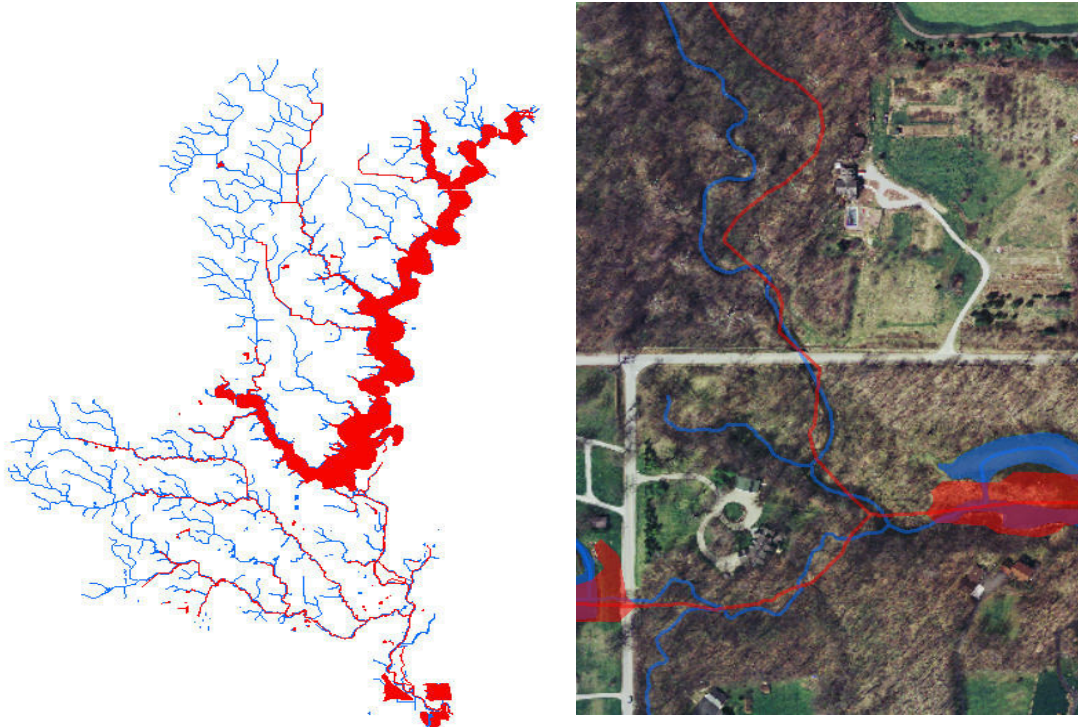
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2.4.1.0 OVERVIEW

The purpose of this project is to develop a functional Local-Resolution hydrographic data model for the State of Indiana. This project shall meet federal National Hydrography Dataset (NHD) standards for High-Resolution and Local-Resolution watershed data set forth by the United States Geological Survey (USGS).

The project will utilize current NHD 1:24,000 high-resolution hydrography source data for Indiana and conflate this information to newly created 1:2,400 or 1:1,200 hydrography geometry created from



Indiana's 2005 Orthophotography and DEM datasets. The Local-resolution NHD data will be produced and delivered by individual USGS-Hydrologic Unit Code (HUC) 8 Subbasins as defined by the exiting High-Resolution NHD data, with edge-matching to all adjacent HUC 8 Subbasins (both inside and outside of the State of Indiana). Subbasins extending outside the State of Indiana will be converted and conflated as complete catchment areas out to the next confluence.

In the examples shown above, the 1:24,000 High-resolution NHD data for one stream is shown in red over new 1:1200 Local-resolution NHD data captured in blue. As can be clearly seen in this figure, the new Local-resolution NHD data provides a more detailed hydrography network model of each stream, and more accurate (X,Y, and Z) geographic locations for each feature. After completing each subbasin, the new Local-resolution data will be delivered to the State and to the USGS for review and acceptance. Upon acceptance, these datasets will be loaded by the USGS onto The National Map, and IGIC will load the new data onto the IndianaMap.

The Respondent must adhere to USGS rules for NHD editing and allow for USGS involvement in the quality control and data transfer process. Once NHD attributes have been properly edited\modified to the 1:2,400 hydrography datasets, a detailed QA/QC will take place on flow direction and topology to ensure NHD standard compliance.

The Respondent must demonstrate, through previous experience and completed projects, proficiency in all these areas, including demonstrated proficiency in USGS's NHD tools, QA/QC processes, and data

delivery. The Respondent shall produce the data in an ArcGIS 9.3 or higher (exact version contingent of USGS certification) compatible with the USGS NHD Geodatabase and NHD toolset.

This project will produce Local-resolution NHD data for the 38 watershed subbasins that cover the state of Indiana. This program will greatly improve the geographic, topology, and attribution accuracy of the National Hydrography Dataset for the Indiana subbasins.

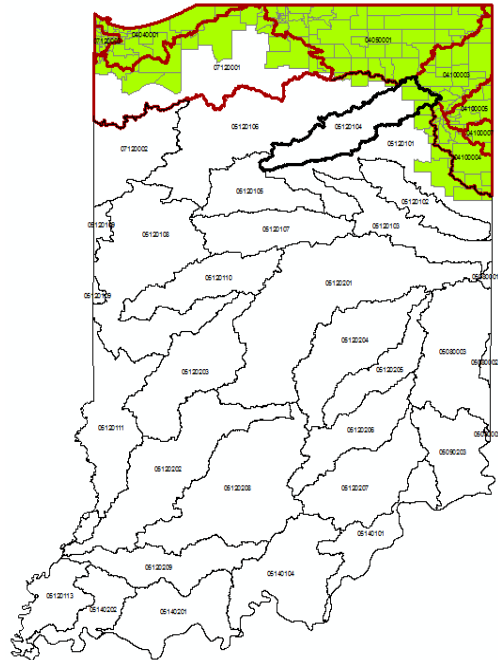
Phase 1

Funds are currently available to develop the first phase of Local-resolution NHD production. Phase 1 covers the Great Lakes Initiative (GLI) area of Northern Indiana. For Phase 1, nine (9) HUC-8 subbasins will be produced. The USGS is funding the one subbasin outlined in heavy black, and the State is funding the eight subbasins outlined in red. The USGS subbasin, named the Upper Eel River (05120104), will serve as the initial Pilot area for this project.

Phase 2 and Beyond

The remaining 29 watersheds covering Indiana require funding. Other specific priority areas in the state will be determined based on local or regional priorities and the availability of additional program funding.

Individual work orders for groups or single watersheds will be written against this master contract as funding becomes available. The State anticipates funding for all of Indiana's 38 watersheds will require several years to acquire, but since each watershed subbasin is a separate piece of the puzzle, the project can be completed as funding becomes available. The State will prioritize local-resolution watershed development so if funding is not available to develop all watersheds, those at the bottom of the priority list will remain as high-resolution NHD products until funding becomes available.



2.4.1.1 Project Schedule

The target completion date for Phase 1 is June 30, 2010, with incremental deliveries of the 1 Pilot subbasin and the 8 other subbasins in Phase 1 to be scheduled at the kickoff meeting.

2.4.1.2 Definitions

For the purpose of this RFP the following definitions apply:

Catchment Area: A term used to describe a drainage basin. Other terms used are catchment, catchment basin, drainage area, river basin, water basin and watershed. In the technical sense, a catchment refers to a divide that separates one drainage area from another drainage area. Catchment areas drain into other catchment areas in a hierarchical pattern, with smaller sub-drainage catchment areas combining into larger catchment areas (HUC 8 subbasins). For purposes of this project catchment areas are to be no larger than 6 acres in size.

High-Resolution National Hydrography Dataset: For Indiana, the High-resolution 1:24,000 NHD, jointly developed by the US Geological Survey (USGS) and the Environmental Protection Agency (EPA), is a statewide hydrologic data developed from the USGS 7.5-minute quadrangle maps. These data are

available in an ESRI ArcGIS Geodatabase as NHDFlowline, NHDWaterbody, NHDPoint and NHDArea feature classes from <http://nhd.usgs.gov>.

Indiana 1:2,400 Hydrography Vector Data: For Indiana, the Local-resolution 1:2,400 NHD Surface Water Features created from the IndianaMap 2005 Source Data [or better] to support 6 acre catchment area modeling.

IndianaMap 2005 Source Data: Data from the IndianaMap 2005 Statewide Orthophotography Project includes one-foot/half-foot pixel RGB , 1-meter CIR Orthophotography, and the 5-foot post-spacing Digital Elevation Model (DEM) data.

Local-Resolution National Hydrography Dataset: For Indiana, the local-resolution NHD data includes NHD hydrography line work, waterbody, and area graphics in NHD format to support 6 acre catchment area modeling, and meet horizontal accuracy at 95% confidence level of 5.5 feet or better.

National Hydrography Dataset (NHD): The National Hydrography Dataset (NHD) is the surface water component of The National Map produced at various scales (resolutions) - Low-resolution: 1:100,000, High-resolution: 1:24,000, and Local-resolution: 1:4,800/1:2,400/1:1,200 designed to show all NHD Surface Water Features.

NHD Surface Water Features: The hydrologic data network including, but not limited to, rivers and streams, ponds and lakes, springs, canals, wetlands, and shorelines.

2.4.1.3 Acronyms

CIR	Color Infrared
ComID	10-digit integer value that uniquely identifies the occurrence of each NHD feature
CU	Cataloging Unit. The hydrologic unit code for NHD subbasin (HUC 8) was formerly known as the cataloging unit.
EPA	U.S. Environmental Protection Agency
FGDC	Federal Geographic Data Committee
FOD	Feature Object ID
HUC	Hydrologic Unit Code
HUC 8	Subbasin
HUC 12	Sub-watershed
NAD83	North American Datum 1983
NAVD88	North American Vertical Datum 1988
NHD	National Hydrography Dataset
NMAS	National Map Accuracy Standards
NRCS	National Resource Conservation Service
SPCS	State Plane Coordinate System
USGS	United States Geological Survey
WBD	Watershed Boundary Dataset (NRCS)

2.4.2.0 SCOPE OF WORK

2.4.2.1 Overview

Throughout the RFP the Respondent is requested to carefully address the required tasks to best achieve the goals of this project within the confines of a fixed cost bid. On the basis of the outline of major tasks that follow, the Respondent should prepare a detailed business and technical proposal and fixed cost bid.

2.4.2.2 Project Coordinate Systems and Projections

The NHD source data are not projected. It is in geographic coordinates (unprojected lat/long), decimal degrees, NAD83.

All geospatial conversion and conflation processes conducted during this project shall use geographic coordinates in the Albers Conical Equal Area projection, NAD83 Meters.

Name: USA_Contiguous_Albers_Equal_Area_Conic_USGS_version

Projection: Albers

Parameters:

False_Easting: 0.000000

False_Northing: 0.000000

Central_Meridian: -96.000000

Standard_Parallel_1: 29.500000

Standard_Parallel_2: 45.500000

Latitude_Of_Origin: 23.000000

Linear Unit: Meter (1.000000)

Any deviation from using these coordinate systems for this project must be approved in advance by the State Project Team and USGS.

Following the procedures described on page 20 of the NHDGEGCT documentation, or by other means accepted by the State and USGS, the Respondent is responsible to reproject the NHD source data to and from geographic coordinates and Albers Conical Equal Area projection. Any errors (be they topological or based on attributes) due to reprojections or changes in coordinate systems during the lifespan of the project, must be documented and appropriate corrections implemented by the Respondent before the project data will be deemed complete and acceptable. The data must be in Geodatabase format using the schema template that will be provided by the State / USGS. The data will be projected/extracted into the empty schema template using the ArcGIS Distributed Geodatabase/Extract Data Tool

2.4.2.3 Source Data

Source data for this project falls into the two categories of Conversion Source Data and Conflation Source Data. The conversion source data are used to create the new vector (target) hydrography features, while the conflation source data are the 1:24,000 high-resolution NHD data used to conflate to the new hydrography features.

2.4.2.3.1 Conversion Source Data

The State shall supply digital copies of all conversion source data listed below. The State will work with the Respondent to develop a source data delivery schedule that is acceptable to both parties. It is the responsibility of the Respondent to inspect, validate, and report back to the State on the completeness and usability of all State provided source data prior to its use in production.

4.3.1.1 Unless newer and/or better local government data are provided by the State, all source orthophotography and digital elevation model datasets provided by the State during the conduct of this work are from the IndianaMap 2005 Statewide Orthophotography Project. The IndianaMap 2005 Source Data include one-foot/half-foot pixel RGB Orthophotography, and 5-foot post-spacing Digital Elevation Model (DEM) data. One-meter pixel CIR or 4-band imagery is available as an additional visual reference, but CAN NOT be used for spatial reference (e.g. digitizing). All 2005 orthophotography source data will be provided in 4000x4000 tiles in GeoTIFF format. All 2005 DEM source data will be provided in 4000x4000 tiles in IMG file format. All 2005 orthophotography and DEM source data will be provided in either Indiana East or West Zone, NAD 1983 State Plane Coordinate System, in U.S. Survey Feet.

4.3.1.2 Where 1:2,400 scale or better local government hydrography vector data are provided by the State from available local government sources, this data will be provided by the State as an additional source to support the Respondent's Conversion efforts. The Respondent accepts full responsibility for the use of this data and is responsible for any/all corrections and improvements to this data utilizing the source data provided in 4.3.1.1 to meet all of the project requirements.

2.4.2.3.2 Conflation Source Data

The State shall check out each subbasin and provide geodatabase files for each HUC 8 for conflation from the NHD website – <http://nhd.usgs.gov>. Each HUC 8 conflation geodatabase is in NAD83 geographic coordinates, and includes the following featureclasses:

- NHDArea
 - NHDAreaEventFC
 - NHDFlowline
 - NHDLine
 - NHDLineEventFC
 - NHDPoint
 - NHDPointEventFC
 - NHDWaterbody
-
- FGDC compliant Data Dictionary/Metadata files for data supplied.

Note: The State of Indiana is responsible for all GNIS edits/updates. Under a separate project that will be completed in advance of the State delivering this source data to the Respondent, the State is validating and updating the hydrography names in the NHD to match the hydrography names in the GNIS database.

2.4.2.4 Project Startup

The Respondent shall meet with the State's project team immediately following a contract award, at the State headquarters, to discuss the details of the project and all issues related to the timely completion of the project to specifications as defined by the State. Respondent will submit recommended business rules for feature extraction and categorizing, and for scenarios dealing with likely conflation conflicts. The Respondent will provide for approval by the State/USGS the final documented process used to update the target NHD dataset. This documentation will be reevaluated as part of the Pilot project.

Before full production work is authorized, the Respondent's first production task is to perform a Pilot to successfully Convert, Conflate, QC, Deliver, and upload to the USGS the Local-resolution NHD data for the Upper Eel subbasin. Failure to deliver a suitable Pilot product is grounds for early termination of the contract.

2.4.2.5 Conversion Task

Utilizing the conversion source data identified in Section 4.3.1, this task will create local-resolution Indiana 1:2,400 Hydrography Vector Data by HUC 8 subbasin. The local-resolution vector data will include NHD

hydrography flowline, waterbody, and area features to support 6 acre catchment area modeling. The Respondent is responsible for the creation of the 6 acre catchment areas, and shall describe their methodology to accomplish this. A featureclass of the 6 acre catchment areas used shall be delivered to the State with each HUC 8 subbasin delivery.

The conversion task includes all typical USGS NHD Pre-Conflation target-data creation and preparation processes (See "Draft_Operation Guide of NHD GeoConflation Tools for NHDGeoEdit Data 9p3.doc"). Spatial edits in this phase involve the process of Orthophoto/DEM interpretation to create through feature extraction and digitization new hydro features following the Respondents established protocols. Where existing local hydro source data are provided, the Respondent shall propose protocols to be followed to govern the addition, update or deletion of features.

The first conversion task will be to perform a Pilot to successfully convert and deliver to the State for review and acceptance the Local-resolution Indiana 1:2,400 Hydrography Vector Data for the Upper Eel subbasin in the USGS Pre-Conflation data format. Only after the State's review and acceptance of the vector features will the Respondent be authorized to proceed with the Conflation Tasks.

Prior to conflation, the target data must be prepared by undertaking the following steps:

1. The data must be in Geodatabase format using the schema template that will be provided by the State / USGS. The data will be projected/extracted into the empty schema template using the ArcGIS Distributed Geodatabase/Extract Data Tool.
2. All features must have FCodes as per the NHDFCode table. Assigning the correct FCode will assure the feature will be in the correct featureclass layer.
3. Flowlines should have connectivity with flow direction; check with NHD Flowcheck Tool
4. Artificial paths (NHDFlowline) must be created as the artificial centerline for all NHDWaterbody features
5. Connectors (NHDFlowline) must be created for StreamRivers which cross below major roads (e.g. divided highways & interstates). Continue the stream/river over smaller roads with no breaks.
6. Artificial paths must not exist outside of NHD Area and NHDWaterbody; check with "Find Artificial Paths Out of Area Features" script.
7. StreamRivers must not exist inside of NHDArea and NHDWaterbody; check with "Extract Improper Stream/River Flowlines" script.

The USGS Conflation Tools (NHDGEGCT) require a subset of NHD vector coverage (ARC/INFO) inputs that have been feature-coded using Feature Object ID (FOD)-based Fcodes. These inputs basically are the output products of NHDCreate pre-conflation process. The required inputs are:

- NET24 - network line coverage: flow directed set of arcs including centerlines (artificial paths) and connectors that have FOD-based Fcodes,
- LM1D_FC - landmark line coverage (if any) having FOD-based Fcodes,
- HYD2D_FC - waterbody polygon coverage having FOD-based Fcodes,
- NHDPT - point coverage (not yet implemented). This can be a blank NHDPT coverage.
- HUC_EDIT – The edited subbasin boundary that was generated through NHDCreate pre-conflation procedures.

2.4.2.6 Conflation Task

This task is to conflate and generate specific attributes essential for compliance with the USGS NHD standard from the 1:24,000 USGS NHD dataset to the Indiana 1:2,400 Hydrography Vector Data by HUC 8 subbasin, including:

- Conflate NHD 1:24,000 attributes to NHD 1:2,400
- Assign new Reach codes to stream segments and lake/pond/reservoir waterbodies that were not delineated in the High-Res data

- Update compliant codes to NHD 1:2,400 (COMID, Reachcode, GNIS ID and GNIS Name, and other codes)
- Create Local-Resolution NHD Geodatabase model

The Respondent shall utilize the 1:24,000-scale NHD Hydrography geodatabase feature classes to conflate to the new "Indiana 1:2,400 Hydrography Vector Data" feature classes created in the conversion task for each HUC 8 subbasin. The State will provide the 1:24,000 NHD source geodatabase. All edit/modification, attribute processing, reach code generation, and quality control steps must take place using USGS approved software, database and tools.

The first Conflation task will be to perform a Pilot to successfully conflate and deliver to the State and USGS for review and acceptance the Local-resolution hydrography NHD dataset for the Upper Eel subbasin.

2.4.2.6.1 Conflation Software, Database and Tools

The Respondent is required to use the following software, database and tools, unless alternatives are approved by both USGS and the State:*

- ArcGIS and ARC/INFO 9.3 or newer (exact version contingent of USGS certification)
- ArcGIS Utility Network Analyst extension (a standard ArcGIS extension)
- USGS NHD Geodatabase Format (NHDinGEO)
- USGS NHD GeoConflation Tool (NHDGEGCT)
- USGS NHD Utilities

*NOTE: This list is for general reference only, the definitive list of software, database and tools required shall be based on current USGS NHD standards and requirements.

The NHD GeoConflation Tools (NHDGEGCT) - Provides automated capabilities for conflation of local resolution NHD. NHDGEGCT will perform feature delineation and reach code conflation on feature-coded vector hydrography data to produce a subbasin of NHD data in the geodatabase format. All NHDGEGCT processes are performed through an ArcGIS ArcMap interface.

NHD Utilities – The State / USGS will just provide the latest NHD Utilities package for use with this project. The current release is NHDUtilities_20090430.

DO NOT use the **USFS Reprojection Tool** or the **NHD Network Builder** tool.

Conflation steps require detailed, iterative updates to the target reachable features. ArcGIS software expertise and a high degree of familiarity with the NHD data model are required for successful use of the NHDGEGCT tools. The Respondent is required to be trained on the USGS NHD Tools.

2.4.2.6.2 Conflation Steps

The conflation steps involved in generation of NHD datasets are controlled using a combination of ARC/INFO macros and ArcMap GIS menus and scripts developed by USGS. The main steps include transferring or conflating attributes from line and polygonal features, attributing features properly, conflating reach codes, conflating GNIS feature names and ID's to the 1:2,400 datasets, creating unique routes (groups of individual stream line segments), and creating a cross-reference table to contain details of changes in reach coding between the existing High-resolution 1:24,000 NHD dataset and the new Local-resolution 1:2,400 NHD dataset.

Conflation steps are largely automated using the NHDGEGCT tool. Conflation steps ensure that existing reach code, GNIS Name, and GNIS ID attributes from the source High-resolution NHD are transferred to the corresponding stream lines and waterbody polygons in the new Local-resolution NHD where possible.

Where stream and/or lake reach codes do not transfer cleanly, or where new reach codes are needed, the NHDGEGCT produces reach cross reference documentation that will track reach code changes or anomalies.

All of the following conflation steps assume the correct order of processing based on the NHDGEGCT tool. The NHDGEGCT Project Form Toolset includes 18 separate steps (numbered 1-18) that must be followed in numerical order. Each specific step must be completed before the next step can become functional:

1. Check input and build features
 2. Copy NHD schema and load feature classes (projecting data to Albers)
 3. Prepare source waterbodies
 4. Check orientation of target NHDFlowline feature class
 5. Check orientation of source NHDFlowline feature class
 6. Extract source reach features
 7. Transform source coverages
 8. Conflate 2D features and assign underlying feature code to target network
 9. Conflate 1D features
 10. Transfer source reach codes to target features classes
 11. Interactive review and update of conflated data
 12. Generate temporary reach codes for all new reachable features and populate reachxref table
 13. Process and review underpass situations, if needed
 14. Review and update GNIS data
 15. Assign ComID's and build Status table
 16. QAQC dataset
 17. Allocate permanent reach codes and substitute the temporary reach codes
 18. Project to geographic coordinate system (DD) for delivery
19. Submit HUC 8 subbasin geodatabase in NHDinGEO format to the State and upload to USGS for QA/QC review and acceptance testing.

Steps 1 through 7 effectively prepare the source and target datasets for flowline and waterbody feature conflation. Steps 8-17 are the primary conflation steps, and step 18 prepares the data for delivery. These 18 steps are outlined in detail in the following document provide with the USGS conflation tools:

"Draft_Operation Guide of NHD GeoConflation Tools for NHDGeoEdit Data 9p3.doc"

Finally, Step 19 - Submit HUC 8 subbasin geodatabase in NHDinGEO format to the State and upload to USGS for QA/QC review and acceptance testing.

The Respondent will submit an ESRI geodatabase in USGS NHD Geodatabase Format (NHDinGEO) for each completed HUC 8 dataset, plus FGDC metadata for the State and USGS to review all conflation and determine accuracy. Any edits deemed necessary by either the State or USGS may/will be sent back to the Respondent for corrections and redelivery.

All final deliverables must meet standards defined by the NHD and available at <http://nhd.usgs.gov>

2.4.2.7 Quality Control / Quality Assurance Tasks

The Respondent shall provide a detailed project QA/QC plan with reference to specific tests or procedures to insure the quality of the final product. The QA/QC plan should include but not necessarily be limited to: resolving topology errors for NHDFlowline, NHDArea and NHDWaterbody; finding and fixing artificial paths and streams/rivers inside of NHDArea and NHDWaterbody; using the NHD Flowcheck tool to find and resolve errors; finding and fixing GNIS naming errors using the gapped_or_branched_attribute_tool.

As each conflated subbasin dataset is delivered, the State and USGS will conduct a QA/QC process to determine if all NHD requirements have been met, and if indeed the deliverables can be considered "NHD Compliant" according to federal regulations. The State and USGS reserve the right to request edits be made by the Respondent when and if necessary once the QA/QC process has determined NHD compliance HAS NOT been met. For the initial Pilot delivery the Respondent will make a special interim delivery of conflated data after Step 11 is completed and before starting on Step 12.

In the event that new/updated software tools and/or programs are created/edited to enhance the completion of this project (and the advancement of the NHD), the State reserves the right to request that the Respondent implement these tools in the production of all future HUC 8 data conflation and delivery steps.

2.4.2.8 Reporting

Throughout the lifespan of the project, the Respondent is required to communicate on a weekly basis with the State staff contacts on the project status. Communication may take place in the form of telephone calls, e-mail, or use of other online tools as mutually agreed upon by all parties.